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ABSTRACT

In a previous study (Watson, 1960), college students were told that a three-number string ("2, 4, 6") conformed to a rule and that they had to guess the rule by proposing other three-number strings; they were then told whether each guess was right or wrong. However, it was suspected that, since the subject's hypothesis was falsified by an experimenter, the true value of instructing students to falsify would only become apparent if they had to decide whether their hypotheses were right or wrong without being able to ask the experimenter. Psychology students (N=120) were assigned to one of three strategies: (1) confirmatory--proposing strings subjects thought would be correct if their hypotheses were correct; (2) disconfirmatory--proposing strings subjects thought would be incorrect if their hypotheses were correct; and (3) control--testing hypotheses without any suggestions as to how to go about testing. Results indicate that once experimenter feedback concerning the correctness of hypotheses was eliminated, disconfirmatory instructions greatly improved subjects' performance on the string task. Subjects instructed to disconfirm obtained a higher proportion of incorrect strings and were more likely to test a hypothesis with an incorrect string, suggesting that their instructions helped them avoid the "confirmation bias" noted in earlier research. (JN)

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THE EFFECT OF DISCONFIRMATORY INSTRUCTIONS ON SCIENTIFIC PROBLEM-SOLVING

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Wason (1960) told college students that the three-number string '2, 4, 6' conformed to a rule; he wanted them to guess the rule by proposing other three-number strings while he told them whether each was right or wrong. Most of the subjects would propose strings they thought should be right, e.g., '8, 10, 12' and '14, 16, 18.' Wason took this as evidence of a 'confirmation bias' on the part of the students: very few of them played strings like '3, 2, 1' that should be wrong if the rule were 'even numbers ascending by twos.' In other words, students failed to seek evidence that had the potential to falsify their hypotheses. As a consequence, many students had trouble guessing the correct rule, which was simply that the three numbers must ascend. Mahoney (1976) found that scientists displayed a similar confirmation bias on this task.

Tweney et al. (1980) instructed students to employ either a confirmatory or a disconfirmatory strategy on Wason's '2, 4, 6' task and found that there were no significant differences between the two conditions, in terms of the number of correct solutions obtained. But each time Tweney's subjects announced a hypothesis, the experimenter told them whether it was right or wrong, thereby giving many of them falsificatory information. For example, a subject who played three strings and announced that the rule was 'even numbers ascending by twos' was told that his/her hypothesis was wrong, then was allowed to continue the

task. This subject's hypothesis was falsified by the experimenter.

The present author suspected that the true value of instructing students to falsify would only become apparent if the students had to decide whether their hypotheses were right or wrong without being able to ask the experimenter. As Tweney, Doherty & Mynatt (1981) point out, falsification is most useful late in the inference process, when the scientist already has a clearly-formulated hypothesis. Similarly, falsification would be most effective on the '2, 4, 6' task after students had formulated a hypothesis, which is precisely when most of them turn to the experimenter and ask if their hypotheses are correct. If students cannot appeal to the experimenter, then those students who know how to falsify their hypotheses should do better than students instructed to confirm or follow a control strategy.

Procedures

One-hundred-and-twenty introductory psychology students were randomly assigned to one of three strategy conditions: confirmatory, disconfirmatory or a control, no-strategy condition. Confirmatory subjects were instructed to test their hypotheses by coming up with number strings that should be correct if their hypothesis were correct. For example, to test the hypothesis that the rule was 'three equal numbers', they could try number triples like 2,2,2 or 3,3,3 or 22,22,22. Disconfirmatory subjects, in contrast, were told to test their hypotheses by coming up with number strings that should be

incorrect if their hypothesis were correct, e.g., 5,7,9 to test the hypothesis that the rule was 'three equal numbers.' In other words, confirmatory subjects were told to propose strings they thought would be correct and disconfirmatory subjects were told to propose strings they thought would be incorrect. Control subjects were just urged to test their hypotheses without any suggestion as to how they were to go about testing.

All subjects worked individually on Wason's '2, 4, 6' task and were given no feedback concerning whether their hypotheses were right or wrong until the end of the experiment. (For more details concerning the specific instructions and procedures used on this and two related tasks, see Gorman & Gorman, In Press). It was predicted that subjects in the disconfirmatory condition would solve the rule significantly more often than subjects in the confirmatory or control conditions.

Results

Results were quite dramatic: 38 out of 40 subjects instructed to disconfirm solved Wason's rule, as opposed to only 19 out of 40 subjects instructed to confirm and 21 out of 40 subjects in a control condition ($\chi^2 = 10.76$, $df=2$, $p<.005$). On the average, 41% of the strings proposed by disconfirmatory subjects were incorrect, as opposed to 22% of the strings obtained by confirmatory subjects and 21% by subjects in the control condition ($F(2,117)=22.37$, $p<.0001$). A record was also kept of whether each subject tested at least one of his or her announced guesses with a string he or she predicted would be wrong: disconfirmatory subjects proposed a string they though would be

incorrect after they had announced a guess significantly more often than subjects in other conditions ($X^2 = 11.48$, $df = 2$, $p < .005$).

Discussion

Once experimenter feedback concerning the correctness of hypotheses was eliminated, disconfirmatory instructions greatly improved subjects' performance on the '2,4,6' task. Subjects instructed to disconfirm obtained a higher proportion of incorrect strings and were more likely to test a hypothesis with an incorrect string, indicating that their instructions had helped them avoid the 'confirmation bias' first noted by Wason (1960). As Gorman, Gorman, Latta & Cunningham (1984) showed, these results generalize to a different task and situation. These authors compared the performance of groups using either confirmatory, disconfirmatory or control instructions on "New Eleusis", a task that models the 'search for truth.' As in the present study, disconfirmatory groups obtained disconfirmatory information about 41% of the time and therefore solved significantly more rules than groups in other conditions. (Reprints of the Gorman et al. study are available upon request).

A caveat: When the rule on the '2 4 6' task is 'no two numbers can be the same,' disconfirmatory instructions do not lead to superior performance (Gorman & Gorman, 1984). Therefore, results of the present study can be generalized to real-world science only with the greatest caution; more research is needed to determine under what conditions a disconfirmatory strategy is most effective. For example, whereas subjects' experiments on the '2 4 6' task always yield reliable results, the real-world

scientist knows that a single experiment never falsifies a theory--that experiment must be replicated many times before its result is considered reliable. The present author is conducting further research to determine how the possibility of error affects subjects' performance on problems like the '2 4 6' task.

References

- Gorman, Michael E. & Gorman, Margaret E. A comparison of disconfirmatory, confirmatory and a control strategy on Wason's 2,4,6 task. Quarterly Journal of Experimental Psychology, In Press.
- Gorman, Michael E., Gorman, Margaret E., Latta, R.M. and Cunningham, G. How disconfirmatory, confirmatory and combined strategies affect group problem-solving. British Journal of Psychology, 1984, 75, 65-79.
- Mahoney, M.J. Scientist as subject: the psychological imperative. Cambridge, MA: Ballinger, 1976.
- Popper, K.R. Conjectures and Refutations. New York: Basic Books, 1962.
- Tweney, R.D., Doherty, M.E. & Mynatt, C.R. (Eds.) On Scientific Thinking. New York: Columbia University Press, 1981.
- Tweney, R.D., Doherty, M.E., Worner, W.J., Pliske, D.B., Mynatt, C.R., Gross, K.A., & Arkkelin, D.L. Strategies of rule discovery on an inference task. Quarterly Journal of Experimental Psychology, 1980, 32, 109-123.
- Wason, P.C. On the failure to eliminate hypotheses in a conceptual task. Quarterly Journal of Experimental Psychology, 1960, 12, 129-140.